NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE LOW PRESSURE, UNDERGROUND, PLASTIC PIPELINE

(ft)

CODE 430EE

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

PURPOSE

To prevent erosion or loss of water quality or damage to the land, to make possible the proper management of irrigation water, and to reduce water conveyance losses.

CONDITIONS WHERE PRACTICE APPLIES

The standard includes the design criteria and minimum installation requirements for low pressure plastic irrigation pipelines, and specifications for the thermoplastic pipe.

This standard applies to underground thermoplastic pipelines from 4 to 27 inches in diameter that are subject to working pressures less than 50 $lb/in.^2$.

Plastic pipeline requiring a working pressure equal to or greater than 50 $lb/in.^2$ shall be in accordance with NRCS Standard for High Pressure Underground Plastic Pipeline (430DD).

All pipelines shall be planned and located to serve an integral part of an irrigation water distribution or conveyance system designed to facilitate the conservation use and management of the soil and water resources on a farm or group of farms.

The water quantity, quality, pipeline capacity, and rate of irrigation delivery for the area served by the pipeline shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application method to be used.

Plastic pipelines installed according to this standard shall be placed only in suitable soils where the bedding and backfill requirements can be fully met.

This standard applies to pipelines with stands and vents open to the atmosphere and to pipelines not open to the atmosphere but provided with pressure relief valves (PRV) and air relief valves (ARV).

CRITERIA

Capacity. The design capacity of the pipeline shall be sufficient to provide an adequate irrigation stream for all methods of irrigation planned.

Friction Losses. For design purposes, friction head loss shall be no less than that computed by the Hazen-Williams equation, using a roughness coefficient “C” equal to 150 or the Manning’s equation “n” value of 0.009.

Outlets. Appurtenances to deliver water from the pipe system to the land, to a ditch or a reservoir, or to any surface pipe system shall be known as outlets.

Outlets shall have adequate capacity at design working pressure to deliver the required flow to:

- The hydraulic grade line of a pipe or ditch,
- A point at least 6 in. above the field surface, or
- The design surface elevation in a reservoir.

Working Pressure and Flow Velocity. The designer shall determine the working pressure (operating pressure, hydraulic transients, static pressure) and the minimum pressure rating of the pipe. The required minimum pressure rating of the pipe shall be stated on the construction drawings or included in the construction specifications.

As a safety factor against surge or water hammer, the working pressure should not exceed 72 percent of the pressure rating of the pipe, nor should the design flow velocity at system capacity exceed 5 ft/s. If either of these limits is exceeded, special consideration must be given to the flow conditions and measures taken to adequately protect the pipeline against surge.

Plastic pipe pressure rating normally is based on a water temperature of 73.4 °F. Factors for adjusting allowable working pressure for higher water temperature is given in **Table 1**.

Table 1

Pressure Rating Factors for PVC and PE Pipe for Water at Elevated Temperatures

Temperature °F	PVC	PE
73.4	1.00	1.00
80	0.88	0.92
90	0.75	0.81
100	0.62	0.70
110	0.50	—
120	0.40	—
130	0.30	—
140	0.22	—

Note: To obtain the pipe's reduced pressure rating because of a water temperature greater than 73.4 °F, multiply the normal pressure rating by the appropriate factor from table.

Check Valves. A check valve shall be installed between the pump discharge and the pipeline if back flow may occur.

Any in-line check valves installed in an irrigation pipeline, to prevent pollution to the water source from chemigation injection, shall meet the current regulations of the New Mexico Department of Agriculture. Any inline check valve system for chemigation shall have, as a minimum, the following features:

- An automatic quick closing, spring assisted check valve, located in the main line of the irrigation supply line.
- An automatic low pressure drain valve, located between the check valve and the irrigation supply pump.
- An automatic vacuum relief valve, located between the check valve and the irrigation supply pump.
- An inspection port or a viewing device located in such a manner that the inlet to the low pressure drain can be observed.

All of the above mentioned components shall be installed according to the current or draft regulations of the New Mexico Department of Agriculture.

In addition to the inline check system described above, the following components, as described in the regulations of the New Mexico Department of Agriculture, are also required in the chemigation system to prevent pollution of the irrigation water source:

- A spring-loaded check valve in the chemical injection line, located at the point of injection into the irrigation pipeline.
- A functional device, such as a pressure switch, and functional controls which will stop the irrigation supply pump and the chemical injection pump if the pressure in the irrigation system falls below that required for proper operation of the system.

Pressure Relief Valves. Pressure-relief valves can be used on low-pressure plastic pipelines as an alternative to stands open to the atmosphere. A pressure-relief valve shall serve the pressure-relief function of the open stand or vent for which it is an alternative.

Pressure-relief valves do not function as air-release valves and shall not be used as substitutes for such valves if release of entrapped air is required. Pressure-relief valves shall be used in conjunction with air-and-vacuum valves at all pump stands and at the end of pipelines if needed to relieve surge at the end of the lines.

The flow capacity of pressure-release valves shall be the pipeline design flow rate with a pipeline pressure no greater than 50 percent more than the permissible working pressure for the pipe.

The pressure at which the valve starts to open shall be marked on each pressure-relief valve. Adjustable pressure-relief valves shall be sealed or otherwise altered to ensure that the adjustment marked on the valve is not changed.

Manufacturers of pressure-relief valves marketed for use under this standard shall provide capacity tables, based on performance tests, that give the discharge capacity of the valves at the maximum permissible pressure and differential pressure settings. Such tables shall be the basis for design of pressure setting and of acceptance of these valves. For design purposes use **Table 2** for PRV capacity.

Air Relief Valves. The three basic types of air-relief valves (ARV) for use on irrigation pipelines are described below:

- A combination air and vacuum relief valve, which has a large venting orifice, exhausts large quantities of air from the pipeline during filling and allows air to reenter the line and prevents a vacuum from forming during emptying. This type of valve is sometimes called air vacuum relief valve, air vacuum air relief valve, or air vent and vacuum relief valve. This valve is not continuous acting because it does not allow further escape of air at working pressure once the valve closes. It will allow air to enter the pipe when it is de-pressurized.
- A continuously acting ARV, has a small venting orifice, generally ranging between 1/16 and 3/8 in. in size. This valve releases pockets of air from the pipeline once the line is filled and under working pressure.
- A continuous acting combination air and vacuum relief valve combines the functions of both the continuously acting ARV and the combination air and vacuum relief valve. Both valves are housed in one valve body.

Table 2

Pressure Relief Valve Capacity

Pressure relief Valve	Flow Rate GPM
3	650
4	1,000
6	1,500

If needed to provide positive means for air escape during filling and air entry while emptying, the appropriate air and vacuum relief valves shall be installed at all summits, at the entrance, and at the end(s) of the pipeline. Such valves generally are needed at these locations if the line is truly closed to the atmosphere. However, they may not be needed if other features of the pipe system, such as permanently located sprinkler nozzles or other unclosed service outlets, adequately vent the particular location during filling and emptying operations.

The ratio of ARV diameter to pipe diameter for valves intended to release air when filling the pipe should not be less than 0.1 However, small-diameter valves may be used to limit water hammer pressures by controlling air release where control of filling velocities is questionable. Equivalent valve outlet diameter of less than 0.1 are permitted for continuously acting ARV’s. Adequate vacuum relief must always be provided.

Continuous acting ARV’s or continuous acting combination air and vacuum relief valves shall be used as needed to permit air to escape from the pipeline while the line is at working pressure. These types of valves shall be sized according to the working pressure and venting requirements recommended by the valve manufacturer.

Air-and-vacuum valves installed according to the section for “Vents” in this standard, can be used instead of open vents, if appropriate.

Air-and-vacuum valves installed according to the section for “Stands Closed to the Atmosphere” in this standard, can be used in conjunction with PRV’s as an alternative to open pump stands. A pipeline is considered open to the atmosphere if at least one stand, vent, or service outlet is unclosed and located so that it cannot be isolated from the system by line gates or valves.

The diameter of the orifice (opening that controls air flow during filling and emptying operations) of an air-and-vacuum valve shall equal or exceed that specified in **Table 3** for the appropriate diameter of pipeline.

Manufacturers of valves marketed for use under this standard shall provide dimensional data, which shall be the basis for selection and acceptance of these valves.

Vents. Vents must be designed into systems open to the atmosphere to provide for the removal and entry of air and protection from surge. They shall:

- Have a minimum freeboard of 1 ft above the hydraulic grade line. The maximum height of the vent above the centerline of the pipeline must not exceed the maximum allowable working pressure of the pipe,
- Have a cross-sectional area at least one half the cross-sectional area of the pipeline (both inside measurements) for a distance of at least one foot up from the centerline of the pipeline. Above this elevation the vent may be reduced to 2 inches in diameter. This cross sectional requirement shall apply when an air-and-vacuum valve is used instead of a vent, but the reduced section shall be increased to the nominal size pipe required to fit the valve's threaded inlet. An acceptable alternative is to install this valve in the side of a service outlet, provided that the riser is properly located and adequately sized. If both an air-and-vacuum valve and a pressure-relief valve are required at the location, the 10-ft/sec velocity criterion given under "Stands Open to the Atmosphere" shall apply to the reduced section,
- Be located at the downstream end of each lateral, at summits in the line, and at points where there are changes in grade in a downward direction of flow of more than 10 degrees.

Table 3
Orifice Opening Versus Pipe Diameter

Diameter of Orifice in	Diameter of Pipeline in
¾	4
1¼	6
1¾	8
2¼	10
2¾	12
3¼	14
3½	15
3¾	16
4	18
4½	21
5½	24

Stands Open to the Atmosphere. Stands shall be used wherever water enters the pipeline system to avoid entrapment of air, to prevent surge pressures, to avoid collapse because of negative pressures, and to prevent the pressure from exceeding the maximum allowable working pressure of the pipe. Open stands may be required at other locations in low-head systems to perform other functions. Stands shall be constructed of steel pipe or other approved material and supported on a base adequate to support the stand and prevent movement or undue stress on the pipeline. Open stands shall be designed to meet or exceed the following criteria:

- Each stand shall allow at least 1 ft of freeboard above design working head. The stand height above the centerline of the pipeline shall be such that neither the static head or the working head, plus free-board, exceed the pressure rating of the pipe.
- The top of each stand shall extend at least 4 ft above the ground surface except for surface gravity inlets or where visibility is not a factor.
- Gravity inlets shall be equipped with a trash guard.
- The downward water velocity in stands shall not exceed 2 ft/s.
- The inside diameter of the stand shall not be less than the inside diameter of the pipeline. This downward velocity criterion applies only to stands having vertical offset inlets and outlets.
- If the water velocity in the stand inlet exceeds three times the velocity in the outlet pipeline, the centerline of the inlet shall have a minimum vertical offset from the centerline of the outlet at least equal to the sum of the diameters of the inlet and outlet pipes.
- The cross-sectional area of stands may be reduced above a point 1 ft above the top of the upper inlet or outlet pipe. The reduced cross section shall not be such that it would produce an average velocity of more than 10 feet/second if the entire flow were discharging through it.
- Vibration control measures, such as special couplers or flexible pipe, shall be

provided as needed to insure that vibration from pump discharge pipes is not transmitted to stands.

Sand traps, when combined with a stand, shall have a minimum inside dimension of 30 in. and shall be constructed so that the bottom is at least 24 in. below the invert of the outlet of the pipeline. The downward velocity of flow of the water in a sand trap shall not exceed 0.25 ft/s.

Gate stands shall be of sufficient dimension to accommodate the gate or gates and shall be large enough to make the gates accessible for repair.

Float valve stands shall be large enough to provide accessibility for maintenance and to dampen surge.

Stands Closed to the Atmosphere. If pressure-relief valves and air-vacuum, valves are used instead of open stands, all requirements under "Stands Open to the Atmosphere" shall apply except as modified below.

The inside diameter of the closed stand shall be equal to or greater than that of the pipeline for at least one foot above the top of the uppermost inlet or outlet pipe. To facilitate attaching the pressure-relief valve and the air-and-vacuum valve, the stand may be capped at this point or, if additional height is required, the stand may be extended to the desired elevation by using the same inside diameter or a reduced cross section. If a reduced section is used, the cross-sectional area shall be such that it would produce an average velocity of no more than 10 ft/s if the entire flow were discharge through it. If no vertical offset is required between the pump discharge pipe and the outlet pipeline and the discharge pipe is "dog legged" below ground, the stand shall extend to a least one foot above the highest part of the pump discharge pipe.

An acceptable alternative design for stands requiring no vertical inlet (when inlet velocity is less than three times that of the outlet pipeline) shall be:

- Construct the dogleg section of the pump discharge pipe with the same nominal diameters as that of the pipeline,
- Install the PRV and the air and vacuum valve on top the upper horizontal section of the dogleg.

Pressure relief and air and vacuum relief valves shall be installed on stands with nominal size pipe required to fit the valves' threaded inlets.

Thrust Control. Anchors or thrust blocks shall be provided on pipelines having a working pressure of 25 lb/sq in. or greater at abrupt changes in pipeline grade, changes in horizontal alignment, or reduction in pipe size to absorb any axial thrust of the pipeline. Thrust blocks may also be needed at the end of the pipeline and at inline control valves.

The pipe manufacturer's recommendations for thrust control shall be followed. In absence of such recommendations, the following formula should be used to design thrust blocks:

$$A = ((98\ HD^2)/B)\sin(a/2)$$

Where:

A = Area of thrust block required
H = Maximum working pressure in ft
D = Inside diameter of pipe in ft
B = Allowable passive pressure of the soil in lb/ft^2
a = Deflection angle of pipe bend

Area of thrust blocks for dead ends and tees shall be 0.7 times the area of block required for a 90º deflection angle of pipe bend.

If adequate soil tests are not available, the allowable bearing soil pressure can be estimated from **Table 4**.

Table 4

Allowable Soil Bearing Pressure

Natural Soil Material	Depth of Cover to Center of Thrust Block			
	2 ft	3 ft	4 ft	5 ft
	pounds per square foot			
Sound bedrock	8,000	10,000	10,000	10,000
Dense sand and gravel mixture Ø≈40º	1,200	1,800	2,400	3,000
Dense fine to coarse sand Ø≈35º	800	1,200	1,650	2,100
Silt and clay mixture Ø≈25º	500	700	950	1,200
Soft clay and organic soils Ø≈10º	200	300	400	500

Flushing. If provisions are needed for flushing the line free of sediment or other foreign material, a suitable valve shall be installed at the distal end of the pipeline.

CONSIDERATIONS

Effects on the water budget, especially on infiltration and evaporation.

Effects on downstream flows or aquifers that would affect other water uses or users.

Potential use for irrigation water management.

Effects of installing a pipeline on vegetation that may have been located next to the original conveyance.

Effects of installing the pipeline (replacing other types of conveyances) on channel erosion or the movement of sediment and soluble and sediment-attached substances carried by water.

Effects on the movement of dissolved substances into the soil, percolation below the root zone or to ground water recharge.

Effects of controlled water delivery on the temperatures of water resources that could cause undesirable effects on aquatic and wildlife communities.

Effects on wetlands or water-related wildlife habitats.

Effects on the visual quality of water resources.

DRAWINGS AND SPECIFICATIONS

Drawings and specifications for constructing low-pressure, underground, plastic irrigation pipelines shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATIONS AND MAINTENANCE

Provisions shall be made as necessary for operations and maintenance requirements and may include a formal plan for larger or more complex designs.

The pipe will be checked for leaks and evidence of leaks on an annual basis.

Pipe supports will be checked, on an annual basis, for erosion and animal or human activity that may damage or affect the proper operation or integrity of the pipe.

Any damage will be promptly repaired